10/526094
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TREE HARVESTER ASSEMBLY

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] This invention is directed to an apparatus for harvesting trees whereby the trunk of a tree is grasped and a chain saw severs the trunk proximate to its base.

Description of Related Art

[0002] Tree harvesting involves the removal of trees by cutting so that the tree may be processed for industrial or commercial applications. A common problem while cutting trees occurs as a chain saw enters the final phase of cutting. In particular, as a chain saw removes material to produce a groove within the tree, the saw advances through the tree and the remaining portion of the tree in front of the chain saw is incapable of supporting the entire weight of the tree. For that reason, the tree begins to tilt and to pinch the chain saw. It is fairly common for a chain saw to stall and, to overcome this hurdle, the chain saw may be oversized such that it has surplus power to continue operating even after the tree pinches the saw. As a result, larger chain saws are used not because of the difficulty in penetrating the wood of the tree, but to overcome the friction caused by the tree when it pinches upon the saw blade.

[0003] Additionally, it is important to maintain the chain of the chain saw at the proper tension to insure proper operation. Some prior art arrangements adjust the tension of the chain when the chain is hot such that, upon cooling, the chain retracts at a greater rate than the chain bar, thereby putting excessive tension upon the chain which may cause damage to either the chain or the chain bar.

[0004] Additionally, many tree harvesting machines secure the trunk of a tree within a tower utilizing interlocking clamps. As a result, when it is necessary to release the tree, all the clamps must be simultaneously released which permits little or no flexibility in selecting the direction in which the tree trunk will far.

SUMMARY OF THE INVENTION

[0005] The subject invention is directed to a tree harvester having a pivoting securing tower, a pivoting chain saw guide, an arrangement to secure a tree trunk within the tower, a chain saw pivoting/driving apparatus, and a chain saw tensioning device.

[0006] One aspect of the invention is an apparatus for cutting trees to complement the operation of a chain saw, wherein the apparatus is supported upon a structure and wherein the apparatus comprises:

a) a chain saw guide secured to the structure, wherein the guide has:

1) an opening adapted to accept a tree trunk,

2) a generally planar bottom surface adapted to rest upon the terrain; and

3) a chain saw pivotally mounted to the guide about an axis to traverse the entire opening along a plane parallel to the planar bottom surface from a starting cut position to a finishing cut position, wherein the starting cut position defines a starting cut point and wherein the finishing cut position defines a finishing cut point;

b) a securing tower for selectively securing and releasing the tree trunk, wherein

1) the securing tower has a centerline extending along its length,

2) the securing tower is pivotally supported by a tower pivot mounted upon the structure to provide rotation about a tower pivot axis, and

3) the tower pivot axis is located above and offset in a direction away from the finishing cut point, such that a tree trunk secured within the tower will be urged upward and away from the finishing cut point when the tower is pivoted away from the chain saw guide.

[0007] Another aspect of the invention is an apparatus for cutting trees on a sloping terrain, wherein the apparatus is supported upon a structure, wherein the apparatus comprises:

a) a chain saw guide pivotally connected to the structure, wherein the chain saw guide has an opening to accept a tree trunk, a generally planar bottom surface adapted to rest upon the terrain and a chain saw pivotally mounted to the guide to traverse the entire opening along a plane parallel to the planar bottom surface from a starting cut position to a finishing cut position, wherein the starting cut position defines a starting cut point and wherein the finishing cut position defines a finishing cut point, and

b) securing tower for selectively securing and releasing the tree trunk.

[0008] Another aspect of the invention is an apparatus for securing trees during and after a cutting operation using a chain saw, wherein the apparatus is supported upon a structure and wherein the apparatus comprises:

a) a securing tower adapted to secure a tree trunk therein, wherein the tower has an upper end and a lower end, which define the length and wherein the tower further has a first side, a second side and a rear side;

b) a stabilizer at the upper end of the tower,

c) at least one clamping arm on each the first side and the second side of the tower, wherein each arm is spaced from the other arm and each bar is positioned at a different location along the length of the tower and wherein at least one clamping arm may

independently pivot from an open position to a closed position suitable to embrace the tree against the tower or release the tree from the tower, and

d) at least one blade protruding from the rear side of the tower, wherein the blade has an edge adapted to penetrate a tree trunk when the tree is embraced within the tower.

[0009] Yet another aspect of the invention is a tensioning apparatus for a chain on a chain saw comprising:

a) a base with a drive sprocket rotatingly mounted therein about an axis;

b) a chain saw bar secured to a chain support and slidingly mounted to the base in a direction radial to the sprocket axis, wherein the bar has an outer rim;

c) a chain supported by a chain support and attached to the drive sprocket and engaged and guided to slide over the outer rim of the chain saw bar; and

d) a biasing element, which urges the chain saw bar in the radial direction away from the sprocket, thereby imparting a tension to the chain.

[0010] Yet another aspect of the invention is an apparatus for radially pivoting and driving a chain saw comprising:

a) a base having a cylindrical bore extending therethrough about an axis;

b) a cylindrical hub rotatingly mounted within the bore of the base about the axis, wherein the hub has a cylindrical bore extending therethrough, wherein the chain saw is mounted upon the exterior of the cylindrical hub;

c) a drive shaft extending through and rotatably supported within the bore of the hub about the axis;

d) a hub drive mechanism for rotating the cylindrical hub through a range of rotational motion about the axis, wherein the chain saw is thereby pivoted through the same range of rotational motion; and

e) a chain drive mechanism for rotating the drive sprocket on the chain saw to drive the chain.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0011] Figure 1 is a front view of the tree harvester in accordance with the subject invention;

[0012] Figure 2 is a side view of the tree harvester in accordance with the subject invention;

[0013] Figure 3 is a top view of the tree harvester in accordance with the subject invention;

[0014] Figure 4 is a schematic of the side view of the tree harvester in accordance with the subject invention illustrating the pivotal motion of the tower;

[0015] Figure 5 is a schematic of the side view of the tree harvester in accordance with the subject invention illustrating the pivotal motion of the chain saw guide;

[0016] Figure 6 is a schematic of the side view of the tree harvester in accordance with the subject invention further illustrating the pivotal motion of the tower;

[0017] Figure 7 is a top view of the chain saw guide;

[0018] Figure 8 is a schematic side view illustrating details of the mechanism to rotationally orient and to drive the chain saw; and

[0019] Figure 9 is a perspective view of the arrangement illustrated in Figure 8.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] Figures 1-3 illustrate a front, side and top view of the tree harvester in accordance with the subject invention. The subject invention will be described in the context of five aspects, which include:

[0021] 1) a pivoting securing tower 10;

[0022] 2) a pivoting chain saw guide 200 (Figure 2);

[0023] 3) an arrangement 400 to secure a tree trunk within the tower 10 (Figure 3);

[0024] 4) a chain saw pivoting/driving apparatus 600 (Figure 8); and

[0025] 5) a chain saw tensioning device 800 (Figure 8).

[0026] As a brief overview, the tree harvester 5 is positioned, as illustrated in Figure 1, such that the securing tower 10 is adjacent to the trunk 7 of a tree 8. Clamping arms 405, 410 pivot inwardly to embrace the trunk 7 against the securing tower 10. A chain saw 205 (Figure 2) is pivoted across the path of the trunk 7, thereby severing the trunk 7 from the base 9 of the tree. The trunk 7 is then moved by the securing tower 10 and deposited at a location suitable for further processing.

[0027] Redirecting attention to Figures 1-3, in one aspect of the subject invention, the tree harvester 5 includes an apparatus for cutting trees to complement the operation of a chain saw 205. In particular, the tree harvester 5 is mounted upon a structure 15, which for purposes of our discussion, will be considered to be stationary unless specified otherwise. In a typical application, the structure 15 may be mounted upon a construction vehicle such as a bulldozer capable of supporting the entire weight of the tree harvester 5 so the tree harvester 5 may be transported and positioned around trees slated for removal. However, the structure 15 is intended only to illustrate a means of supporting and manipulating the tree harvester 5.

[0028] The tree harvester 5 is comprised of a chain saw guide 200 secured to the structure 15. The chain saw guide 200, as illustrated in Figures 2 and 3, has an opening 210 to accept a tree trunk 7. The chain saw guide 200 additionally has a generally planar bottom surface 213

adapted to rest upon terrain adjacent to the tree 8. The chain saw guide 200 has a chain saw 205 (Figure 2) mounted to the guide 200 about an axis 215 (Figure 2) to traverse the entire opening 210 along a plane 217 parallel to the planar bottom surface 213 from a starting cut position to a finishing cut position, wherein the starting cut position occurs when the chain saw 205 first contacts the tree trunk 7 to define a starting cut point 220 and, wherein the finishing cut position occurs as the chain saw 205 passes through the last portion of remaining material, thereby defining a finishing cut point 23.

[0029] The securing tower 10 of the tree harvester 5 is for selectively securing and releasing the tree trunk 7. The securing tower 10 has a centerline 13 extending along its entire length. The securing tower 10 is pivotally supported by a tower pivot 17 mounted upon the structure 15 to provide rotation about a tower pivot axis 20. The tower pivot axis 20 is located above and offset in a direction away from the finishing cut point 23 when the securing tower 10 is pivoted away from the chain saw guide 200. Such an arrangement is schematically illustrated in Figure 4.

[0030] This feature permits nearly unencumbered advancing of the chain saw 205 through the tree trunk 7 since the tree trunk 7, when secured by the tower 10, may be lifted up and away from the trunk 7 to substantially reduce or eliminate pinching by the weight of the tree 8 that would normally rest upon the chain saw 205.

[0031] This feature provides a number of benefits. First of all, since the chain saw 205 may pass unencumbered through the trunk of the tree without the need for increased power to overcome frictional forces generated when the tree pinches against the chain saw, then the chain saw may become smaller in size, weight and power. Additionally, without the weight of the tree trunk bearing upon the chain saw, the wear and tear upon the chain saw is substantially reduced.

[0032] While the securing tower 10 may be pivotally supported about the tower pivot 17, the chain saw guide 200 may also be pivotally supported by a chain saw guide pivot 225 mounted upon the structure 15 to provide rotation about a chain saw guide pivot axis 227. It should be appreciated that the securing tower 10 in one embodiment does not rest directly upon the structure 15, but that the chain saw guide 200 acts as an intermediate member between the tower 10 and the structure 15. In this fashion, it is possible to pivot the tower 10 and to pivot the chain saw guide 200 with the understanding that whenever the chain saw guide 200 pivots, the pivot 17 of the securing tower 10 is displaced along its arc 24 (Figure 4) defined by a radius from the chain saw guide pivot 225 and the tower pivot 17. The chain

saw guide pivot 225 is located below and away from the tower pivot 17 in a direction away from the finishing cut point 23.

[0033] Figure 5 illustrates the chain saw guide 200 pivoted in an upward position with the tower 10 in a vertical position, while Figure 6 illustrates the chain saw guide 200 in a horizontal position with the tower 10 tilted forward. While in a typical application, the tower 10 will most likely not be tilted to the same degree illustrated in Figure 6, this is illustrated only to show the manner in which the tower 10 may pivot.

[0034] Briefly returning to Figure 5, it should be noted that when the chain saw guide 200 is angled upwardly, while the location of the chain saw guide pivot 225 does not change, the location of the tower pivot 17 moves up and to the right, thereby slightly reorienting the tower 10.

[0035] The pivoting securing tower 10 and the pivoting chain saw guide 200 both serve different purposes, however, may be used in combination with one another to provide increased versatility.

[0036] In particular, it is not uncommon for the terrain adjacent to a tree to be slightly higher than the ground away from the tree. Under these circumstances, the chain saw guide 200 may pivot upward to accommodate this raised surface without the need to elevate the structure 15 at the same time. Additionally, for trees located upon an uneven terrain, the chain saw guide may pivot to conform to the terrain without requiring the structure 15 to also conform to the terrain. As an example, if a bulldozer was supporting the structure 15 and was advancing forward to the base of a hill where a tree was located, with the bulldozer still oriented horizontally at the base of the hill, the chain saw guide 200 may pivot to accommodate the terrain of the hillside. This not only permits easier operation of the tree harvester but, furthermore, the chain saw 205 (Figure 2), since it cuts a path parallel to the bottom of the chain saw guide 200, will sever the tree along a path generally parallel to the ground. In other prior art tree harvesters, the chain saw blade was not pivotable and, as a result, the cut of the tree was required at a higher position so that the chain saw would not be forced into dirt adjacent to the tree on the upper hillside of the tree. Cutting the tree to provide a lower stump also provides a significant safety advantage to the operator of the tree harvester since frequently the vehicle supporting the tree harvester must travel in reverse and, if a tree stump is cut low, there is less concern that the vehicle driven by the operator will be stopped by or tipped by a protruding stump. For these reasons, the pivotable chain saw guide 200 is advantageous over the teaching of the prior art.

[0037] Directing attention to the securing tower 10, a hydraulic cylinder 25 is secured between the structure 15 and the tower 10 to manually displace the tower 10 about the tower pivot 17. This manipulation provides a significant advantage during a cutting operation since, as illustrated in Figure 4, the tower 10 is capable of being tilted rearwardly away from the cut of a chain saw 205, thereby relieving the weight of the tree 8 from the chain saw blade and permitting free, unencumbered cutting by the chain saw 205. Additionally, as will be discussed further, the tower 10 may be tilted forward and the clamping arms 405, 410 may be selectively manipulated to release the trunk of the tree in a preselected direction.

[0038] While each of these pivoting features are beneficial unto themselves, as illustrated in the figures, in a preferred embodiment, the tower pivot 17 rests upon the chain saw guide 200 which itself, through the chain saw pivot 225, pivots about the structure 15. As illustrated in Figure 4, it is important for the finishing cut point 223 to be distant from the tower pivot 17, such that when the tower 10 rotates, the tree 8 is not only urged in a bent position relative to the trunk 7, but is also lifted upwardly relative to the trunk 7.

[0039] The tower pivoting device 25 may be a hydraulic cylinder, however, it should be appreciated that any number of devices capable of rotating the tower 10 about the tower pivot 17, would be suitable.

[0040] The chain saw guide 200 is not significantly affected by the operation of the hydraulic cylinder 25 and, as a result, may move freely up and down. In order to prevent gravity from displacing the chain saw guide 200 outside of its range of motion, the chain saw guide 200 is linked to the tower 10, utilizing a chain 27. The length of the chain 27 is adjustable to orient the chain saw guide 200 in a desired angular orientation, such as, for example, the orientation illustrated in Figure 5.

[0041] While so far the discussion has indicated that a tree trunk may be secured within the tower, the apparatus for accomplishing such a task will now be discussed.

[0042] Again directing attention to Figures 1-3, the details of the arrangement to secure a tree trunk will be described. The securing tower 10 is adapted to secure a tree trunk 7 wherein the tower has an upper end 412 and a lower end 415 defining a length therebetween. Furthermore, the tower has a first side 417, a second side 420, and a rear side 422. A stabilizer 425 is generally U-shaped for surrounding a portion of the tree trunk 7. A pivotable clamping arm 405 may have a generally C-shaped configuration and is pivotally attached to the first side 417 of the tower 10. The clamp 405 may be pivoted to secure the tree trunk 7 within the stabilizer 425 against the tower 10. Similarly, a clamping arm 410 is pivotally

mounted to the second side 420 of the tower 10 and generally C-shaped such that it may embrace the tree trunk 7 against the tower 10.

[0043] It is important to note that both clamping arm 405 and clamping arm 410 are spaced apart from each other along the length of the tower 10 such that, in their closed position, they do not overlap with one another. Each clamping arm may independently pivot from an open position to a closed position suitable to embrace the tree trunk 7 against the tower 10 or release the tree trunk 7 from the tower 10. A plurality of blades 428, 430 protrude from the rear side 422 of the tower 10, wherein each blade 428, 430 has an edge adapted to penetrate the tree trunk 7 when the tree is embraced within the tower 10. While it may be possible that the force of the clamping arms 405, 410 against the tree trunk 7 within the tower 10 would be sufficient to prevent vertical displacement of the trunk 7 within the tower 10, the introduction of the blades 428, 430 ensures that the clamped tree trunk 7 will not be vertically displaced within the tower 10. There may be an additional blade 431 associated with the chain saw guide 200 to secure the bottom of the trunk 7.

[0044] Clamping arm 432 is mounted to the first side 417 of the tower 10 in a stationary position. While clamping arm 432 may also be pivotable, inasmuch as it provides an opposing force to clamping arm 410 to further stabilize the tree trunk 7, then it is not imperative for it to be pivotable. Nevertheless, it may be pivotable, thereby providing the operator with greater flexibility in releasing the tree. The clamping arms 405, 410, since they may independently pivot from an open position to a closed position, may selectively embrace the tree or release the tree in a controlled fashion to cause it to fall in a particular direction.

[0045] The pivotable clamping arms 405, 410 are each operated by a dedicated drive device illustrated schematically by items 435, 437. The dedicated drive device 435, 437 for each pivotable clamping arm, 405, 410 may be an electric motor and, furthermore, the electric motor may be used in conjunction with a self locking reduction gear unit. A self-locking reduction gear unit remains in the last position it assumed when the motor was de-energized.

[0046] It is possible that one or more of the pivotable clamping arms 405, 410 be comprised of two or more extensions, as illustrated by extensions 440, 442 on clamping arm 405. It is also possible to have a single extension on clamping arm 405 which has the same width as the combined extensions 440, 442. However, with the occurrence of multiple extensions 440, 442 on each clamping arm, it is important that the clamping arms 405, 410 remain spaced apart along the length of the tower such that the adjacent clamping arms are positioned in a non-overlapping fashion.

[0047] The subject tree harvester utilizes an apparatus for radially pivoting and driving a chain saw. Directing attention to Figure 2 as an overview, the chain saw pivoting and driving apparatus is encircled and identified as reference item 600. This apparatus 600 is used to both drive the chain 612 of the chain saw 205 and also to radially orient the chain saw over the range of rotation necessary to sever the trunk of a tree being held within the tower 10. The chain saw pivoting/driving apparatus 600 rests upon the chain saw guide 200, as illustrated in Figures 1, 2 and 8. Directing attention to Figures 7-9, the apparatus 600 is comprised of a base 605 having a cylindrical bore 607 extending therethrough. The chain saw 205 comprised of a bar 610 and a chain 612, is mounted upon the exterior of a cylindrical hub 615 rotatingly mounted within the bore 607 of the base 605.

[0048] A drive shaft 617 extends through and is rotatably supported within a cylindrical bore 620 extending through the cylindrical hub 615. A hub drive mechanism 622 rotates the cylindrical hub 615 through a range of rotational motions about axis 618, thereby carrying the chain saw 205 and pivoting the chain saw 205 through the same range of rotational motion. A chain drive mechanism 625 rotates a drive sprocket 627 on the chain saw 205 to drive the chain 612.

[0049] The hub drive mechanism 622, in one embodiment, is comprised of a driven pulley 630 mounted to a portion of the cylindrical hub 615 and a driver pulley 632 mounted to a motor 635 secured to the base 605, wherein the driver pulley 632 engages the driven pulley 630 through belt 633 to pivot the chain saw 205 within the desirable range. The hub drive mechanism is illustrated as a belt-driven pulley arrangement in Figure 8. Figure 9 illustrates a gear driven system wherein a driver gear 632 engages a driven gear 630. It is entirely possible to provide a hub drive mechanism which uses other known hardware, such as chain driven sprockets instead of meshing gears or a pulley arrangement. Briefly directing attention to the Figure 7, the range of rotation of the chain saw 205 is illustrated by angle 37, which is approximately 180°.

[0050] The motor 635 may be an electric motor and, furthermore, may be an electric motor having braking capability. In particular, a motor having braking capability is one that when in a de-energized state will retain the last position of the energized state.

[0051] As mentioned, with reference to Figure 7, the chain saw 205 may pivot over a range indicated by angle 37. Oftentimes, the chain saw operator using a tree harvester or another device utilizing a pivoting chain saw may not be able to see the chain saw in operation and, therefore, may not know the position of the chain saw relative to a piece being cut. For that

reason, the present invention utilizes sensors to identify the rotational position of the cylindrical hub 615 and the attached chain saw 205. In particular, in one embodiment, a plurality of sensors 640A, B, C, D (Figure 9) may be mounted upon the driven gear 630 with one or more opposing sensors 642 mounted upon the base 605 capable of recording the rotational position of the cylindrical hub 615. Such sensors may consist of Hall effect sensors, reed switch sensors or mechanical sensors known by those skilled in the art of measurements.

[0052] The cylindrical hub 615 is rotatably secured within the base 605 using bearings 645, 647 secured at opposite ends of the cylindrical hub 615.

[0053] As an additional feature, limit switches 650, 652 (Figure 7) may be included such that, when the chain saw 205 reaches its extreme range of motion, the operator will be notified and/or the chain saw will be de-energized.

[0054] Briefly returning to Figure 8, it should be noted that, for illustrative purposes, the chain 612 (Figure 9) is not shown. However, the chain is driven by drive sprocket 627, which is rotated by drive shaft 617, which itself is rotated by pulley 655, which is turned by belt 657 through pulley 660 driven by spindle motor 662.

[0055] The tree harvester in accordance with the subject invention further includes a chain saw tensioning device 800 (Figures 8 and 9) for tensioning the chain 612 on a chain saw 205. The tensioning apparatus 800 is comprised of a base 200 with a drive sprocket 627 rotatingly mounted thereon about an axis 618.

[0056] The chain saw bar 610 is slidingly mounted to the housing 202 of the base 200 in a direction radial to the sprocket axis 618. The chain saw bar 610 has an outer rim 611 upon which the chain 612 is guided. The chain 612 is attached to the drive sprocket 627 and engaged and guided to slide over the outer rim 611 of the chain saw bar 610. At least one biasing element 805 urges the chain saw bar 610 in a radial direction away from the sprocket 627 thereby imparting a tension to the chain 612.

[0057] The chain saw bar 610 is slidingly mounted to the housing 202 of the base 200 through a dovetail configuration 810, 815, wherein one of a dovetail projection 812 or dovetail cavity 817 within the base 200 engages the other of the dovetail projection 812 or dovetail cavity 817 within the chain support 807 which is also the dovetail 815. Dovetail 815 is also the chain support 807.

[0058] The biasing element 805 may be a compression spring fitted between the housing 202 of the base 200 and the chain support 807 to urge the chain support 807 away from the base 200 such that the tension in the chain 612 may be predetermined as a function of the

compression spring 805. In one embodiment, the biasing element 805 may be a compression spring and, furthermore, may be a coil spring. Additionally, the biasing element 805 may be one selected from the group consisting of a hydraulic piston and a pneumatic piston.

[0059] A locking mechanism 820 may be used to secure the change saw bar 610 in a fixed position relative to the housing 202 of the base 200. In particular, the locking mechanism 820 is a friction device that introduces friction between the base 200 and the chain saw bars 610 to prevent sliding motion between them. The locking mechanism 820 may be comprised of a rod 822 extending through one of the chain support 807 or housing 202 of the base 200 and contacting the other to introduce friction between them. The rod 822 is activated to produce friction when the chain 612 is in operation and is deactivated to relieve friction when the chain 612 is not in operation. The rod 822 may be controlled by an air operated actuator 825 or other devices known in the art.

[0060] In operation, the locking mechanism 820 is released such that dovetail 810 and dovetail 815 may slide relative to one another allowing the biasing element 805 to push the chain bar 610 away from the drive sprocket 627, thereby tensioning the chain 612. At the time of operation, the locking mechanism 820 is activated, thereby producing friction between the dovetail 810 and the dovetail 815 to prevent relative motion between to retain the chain tension 615. Each time the chain saw is de-energized, the locking mechanism 820 is also de-energized, thereby permitting the chain saw bars 610 to slide with the dovetail 815 in a fashion permitted by the biasing element 805. As an example, if during operation, the chain 612 becomes loose, then, at the time the chain saw is deactivated, the locking mechanism 820 is also deactivated, thereby permitting the biasing element 805 to push the chain saw bar 610 away from the drive sprocket 627 to again subject the chain 612 to the predetermined tension determined by the biasing element 805. It is necessary to engage the locking mechanism 820 prior to energizing the chain saw since the forces to which the chain saw will be subjected would in many circumstances cause the chain saw bar 610 to be urged toward the drive sprocket 627, thereby loosening the chain.

[0061] While specific embodiments of the invention have been described in detail, it will be appreciated by those skilled in the art that various modifications and alternatives to those details could be developed in light of the overall teachings of the disclosure. The presently preferred embodiments described herein are meant to be illustrative only and not limiting as to the scope of the invention which is to be given the full breadth of the appended claims and any and all equivalents thereof.